

1.0 INTRODUCTION

This Technology Evaluation Report (TER) documents and summarizes the findings of an evaluation of HydroTechnics, Inc. in situ flow sensors in measuring the groundwater flow patterns created by an innovative groundwater circulating well (GCW) installed at Facility 1381 at the U.S. Air Force 45th Space Wing, Cape Canaveral Air Station (CCAS), Florida (Figures 1 and 2). The U.S. Environmental Protection Agency (EPA) National Risk Management Research Laboratory (NRMRL) evaluated the using in situ groundwater flow sensors under the Superfund Innovative Technology Evaluation (SITE) Program. The EPA's evaluation was a component of a comprehensive evaluation of the GCW conducted by the U.S. Air Force Center for Environmental Excellence (AFCEE). The flow sensors were evaluated for the SITE Program by measuring the magnitude and direction of groundwater flow near the GCW and by conducting aquifer hydraulic tests using the GCW.

The GCW selected is a patented system manufactured by Wasatch Environmental, Inc. (WEI). AFCEE's support contractor, Parsons Engineering, managed the overall technology evaluation and was responsible for installation, operation, and optimization of the GCW. The EPA SITE Program managed installation and acquisition of data from in situ groundwater velocity sensors and the aquifer hydraulic testing.

This report documents the activities conducted during the demonstration and summarizes data collected by EPA. Demonstration data collected by AFCEE are documented separately and are not included in this report.

The TER is divided into eight sections. Section 1.0 presents the project background, information on the SITE Program, a description of the technology, and key contacts. Section 2.0 describes the environmental setting of the demonstration site and the objectives of the evaluation, methods and procedures, and modifications to the Technology Evaluation Plan/Quality Assurance Project Plan (TEP/QAPP) (Tetra Tech 2000). Section 3.0 describes the groundwater circulation system, and Section 4.0 describes the groundwater flow sensors. Section 5.0 presents interpretation of data from the groundwater flow sensors used during the evaluation. Section 6.0 presents the results of the technology evaluation, while Section 7.0 presents the conclusions of the evaluation. References are included in Section 8.0.

1.1 PROJECT BACKGROUND

As part of ongoing efforts to address impacts to groundwater from chlorinated solvents, CCAS is conducting a series of pilot-scale treatability studies to obtain site-specific data on performance and cost for potentially applicable remediation technologies. AFCEE identified the WEI GCW as a possible solution for remediation of nonaqueous-phase liquids (NAPL) source areas such as Facility 1381. Facility 1381 was selected as the demonstration site because it was thought to have a favorable site hydrogeologic condition (relatively high hydraulic conductivity) and the presence of a NAPL source.

GCW technologies have been proposed as a cost-effective alternative to traditional pump-and-treat technologies for remediation of groundwater contaminated with volatile organic compounds (VOC). AFCEE developed a comprehensive test plan to evaluate the GCW, which included installation of a 6-inch GCW and 99 microwells that radiate from the GCW; collection of samples from the soil core, groundwater, and air for subsequent geotechnical and chemical analysis; completion of a dye tracer test; and development of a site groundwater flow model. AFCEE alternated operation of the GCW between pump-and-treat mode and circulation mode to obtain reliable data on the relative capabilities of the GCW technology. Samples of groundwater and air were collected during both modes of operation to obtain performance data under various operating scenarios and to allow comparisons of results.

AFCEE invited EPA to participate in an evaluation of a GCW at CCAS Facility 1381. To evaluate the circulation cell, EPA installed in situ groundwater flow sensors to measure the magnitude and direction of groundwater flow near the GCW, and conducted a series of aquifer hydraulic tests. Data from the groundwater flow sensors were collected during (1) long-term pump-and-treat operation, (2) long-term GCW operation, (3) final pump-and-treat operation, (4) aquifer hydraulic tests, and (5) post-GCW operation.

A summary of the various operational periods is provided below.

Long-Term Pump-and-Treat Operation. The GCW was installed at the site in November 1999. After a tidal influence study, tracer test, and a series of short-term aquifer hydraulic tests, the system began operation in pump-and-treat mode in February 2000. The system remained in pump-and-treat mode through April 2000. AFCEE monitored the system to calculate mass removal rates for comparison to rates achieved during other modes of operation by the GCW.

Long-Term GCW Operation. Long-term operation of the GCW was initiated in April and continued until July 2000. The in situ groundwater flow sensors were installed in June 2000. Continuous collection of data on groundwater flow from the sensors was initiated in July 2000.

Final Pump-and-Treat Operation. Final pump-and-treat operation of the GCW was conducted during August 2000. Eight transducers were installed to evaluate changes in hydraulic head in the aquifer during August 2000.

Aquifer Hydraulic Test Operation. A series of aquifer hydraulic tests were conducted in September 2000. Hydraulic head data were collected from the aquifer using eight pressure transducers, and data on direction and magnitude of groundwater flow were collected from the seven in situ groundwater flow sensors.

Post-GCW Operation. The GCW has not operated after aquifer hydraulic testing was completed in September 2001. EPA collected data from the in situ groundwater flow sensors from September 2000 through September 2001 to document groundwater flow during non-operation of the GCW.

1.2 DESCRIPTION OF FLOW SENSOR AND GCW TECHNOLOGIES

The groundwater flow sensors installed at CCAS were developed at Sandia National Laboratories and manufactured by HydroTechnics, both of Albuquerque, New Mexico. The flow sensors are in situ instruments that use a thermal perturbation technique to directly measure the velocity of groundwater flow in unconsolidated, saturated, porous media. The flow sensors differ from other devices to measure groundwater velocity in that they are in direct contact with the unconsolidated aquifer matrix where the flow is to be measured, thereby avoiding borehole effects. The flow sensor is a thin, cylindrical device that is permanently buried at the depth where the velocity of groundwater flow is to be measured.

The WEI GCW is an in situ groundwater remediation system designed to circulate groundwater in the aquifer and strip VOCs. In the WEI system, airlift pumping lifts groundwater from a screen in the lower section of the well. Air is pumped to the bottom of the well by a blower, reducing the weight of the water column. Groundwater and air are then lifted to an upper screen, where the air strips VOCs and the groundwater is allowed to discharge back into the aquifer. The air stream used to strip VOCs is extracted from the wellhead and is treated before it is released to the atmosphere. Groundwater that reenters the

aquifer through the top screen flows vertically downward and can be recaptured by the GCW, so that it can be treated again. The three-dimensional groundwater flow regime developed by the GCW is termed a “circulation cell,” and its characteristics are critical to the effectiveness of the technology. Key parameters of the circulation cell are its size, or radius, and its percent capture (Parsons 1999a).

1.3 THE SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION PROGRAM

EPA's Office of Solid Waste and Emergency Response (OSWER) and Office of Research and Development (ORD) created the SITE Program in response to the Superfund Amendments and Reauthorization Act of 1986 (SARA). The SITE Program promotes the development, evaluation, and use of new or innovative technologies to clean up Superfund sites across the country.

The primary purpose of the SITE Program is to maximize the use of alternatives in cleaning up hazardous waste sites by encouraging development and evaluation of innovative treatment and monitoring technologies. It consists of three major elements:

- The Technology Evaluation Program
- The Monitoring and Measurement Technologies Program
- The Technology Transfer Program

The objective of the Technology Evaluation Program is to develop reliable data on performance and cost for innovative technologies so that potential users may assess the technology's site-specific applicability. Technologies evaluated are either currently available or are close to being available for remediation of Superfund sites. SITE evaluations are conducted on hazardous waste sites under circumstances that closely simulate full-scale remediation conditions, thus ensuring the usefulness and reliability of the information collected.

Existing technologies that improve field monitoring and site characterizations are identified in the Monitoring and Measurement Technologies Program. This program supports new technologies that provide faster, more cost-effective contamination and site assessment data. The Monitoring and Measurement Technologies Program also formulates protocols and standard operating procedures for evaluation methods and equipment.

The Technology Transfer Program disseminates technical information on innovative technologies in the Evaluation and Monitoring and Measurements Technologies Programs through various activities. These activities increase the awareness and promote the use of innovative technologies for assessment and remediation at Superfund sites. The goal of the technology transfer is to develop communication among individuals who require up-to-date technical information.

1.4 KEY CONTACTS

Additional information on the SITE Program and the evaluation can be obtained from the EPA Project Manager:

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Additional information on AFCEE's evaluation of the GCW technology can be obtained from the AFCEE project manager:

James Gonzales
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3207 North Road
Brooks AFB, Texas 78235-5363
Telephone: (210) 536-4324, Facsimile: (210) 536-4330
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Additional information on the WEI GCW technology or the evaluation can be obtained from the technology vendor:

Tabor DeHart
Wasatch Environmental, Inc.
2410 West California Avenue
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Telephone: (801) 972-8400, Facsimile: (801) 972-8459
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Additional information on in situ flow sensors or this evaluation can be obtained from:

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In addition, information on the SITE Program is available through the following on-line information clearinghouses:

- SITE Program Home Page: <http://www.epa.gov/ORD/SITE>. All recent SITE reports, including this one can be downloaded from this web site.
- The Alternative Treatment Technology Information Center (ATTIC) Internet Access: <http://www.epa.gov/attic>
- Cleanup Information Bulletin Board System (CLU-IN)
Help Desk: (301) 589-8368; Internet Access: <http://www.clu-in.org>
- EPA Remediation and Characterization Innovative Technologies
Internet Access: <http://www.epa.reachit.org>
- Groundwater Remediation Technology Center
Internet Access: <http://www.gwrtac.org>

Technical reports may be obtained by contacting the National Service Center for Environmental Publications in Cincinnati, Ohio. To find out about newly published documents or to be included on the SITE mailing list, call or write to:

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